LIFE AT GREAT DEPTHS.

BY PROFESSOR P. M. DUNCAN.

THE researches of Hooker, who obtained Polyzoa and Foraminifera in soundings at a depth of nearly four hundred fathoms off the icy barrier of the South Pacific, of Wallich in the Atlantic, and of Alphonse Milne-Edwards in the Mediterranean, have had much influence upon geological thought in this age, which, so far as geologists are concerned, is remarkably averse to theory. For many years before any very deep soundings had been taken with the view of searching the sea-bottom for life, geologists had more or less definite opinions concerning the deposition of organisms in sediments at great depths. Certainly more than thirty years ago deep-sea deposits were separated by geologists from those which they considered to have been formed in shallower seas. The finely divided sediment of strata containing Crinoids, Brachiopods, Foraminifera, and simple Madreporaria, was supposed to have been deposited in deeper water than formations containing large pebbles, stones, and the mollusca whose representatives now live in shallows. The relations of such strata to each other during subsidence, the first being found occasionally to overlap the last, proved that there was a deeper sea-fauna in the offing of the old shores which were tenanted by littoral and shallow-water species. The deposition of strata containing Foraminifera, Madreporaria, and Echinodermata, whose limestone is remarkably free from any foreign substances, has been considered to have taken place in very deep water; this theory has been founded upon the observations of the naturalist and mineralogist. Indeed no geologist has hesitated in assigning a great depth to the origin of some deposits in the Laurentian, Silurian, or in any other formation. The "flysch," a great sediment of the Eocene formation, has been considered to have been formed at a very great depth and under great pressure. Its singularly unfossiliferous character was supposed to be due to the absence of life at the depths of the ocean where the sediment collected. But this was a theory of the early days of geology, when the destructive influence of chemical processes in strata upon the remains of organisms in them was hardly admitted.

The great value of such researches as those so ably carried out by Thomson, Carpenter, and Jeffreys is the definite knowledge they impart to the geologist, who is theorizing in the right direction, but whose notions of the depth at which the sediments containing invertebrata can be deposited are indefinite. These researches contribute to more exact knowledge, and they will materially assist the development of those hypotheses which are current amongst advanced geologists into fixed theories. I do not think that any geological theory worthy of the term, and which has originated from geological induction, will be upset by these careful investigations into the bathymetrical distribution of life and temperature. The theories involving pressure and the intensity of the hardness of deep-sea deposits will suffer from the researches; but many difficulties in the way of the palæontologist will be removed. The researches tend to explain the occurrence of a magnificent deep-sea coral fauna in the Palæozoic times in high latitudes, and of Jurassic and Cainozoic faunas on the same area, and they favor the doctrines of uniformity. They explain the cosmopolitan nature of many organisms, past and present, which were credited with a deep-sea habitat, and they afford the foundations for a theory upon the world-wide distribution of many forms during every geological formation.

It is not advisable, however, to make too much of the interesting identities and resemblances of some of the deep-sea and abyssal forms with those of such periods as the Cretaceous, for instance. In the early days of geological science there was a favorite theory that at the expiration of a period the whole of the life of the globe was destroyed, and that at the commencement of the succeeding age a new creation took place. There were as many destructions and creations as periods; or, to use the words of an American geologist, there was a succession of platforms. This theory held back the science, just as the theory that the sun revolved round the earth retarded the progress of astronomy. Moreover it had that armour of sanctity to protect it which is so hard to pierce by the most reasonable opposition. Nevertheless every now and then a geologist recognized the same fossils in rocks which belonged to different periods. A magnificent essay by Edward Forbes on the "Cretaceous Fossils of Southern India," a wonderful production and far before its age * gave hope and confidence to the few palæ-

* Quarterly Journal of the Geological Society of London, vol. i. p. 79.

ontologists who began to assert that periods were perfectly artificial notions — that it did not follow, because one set of deposits was forming in one part of the world, others exactly corresponding to it elsewhere, so far as the organic remains are concerned, were contemporaneous — and that life had progressed on the globe continuously and without a break from the dawn of it to the present time.

The persistence of some species through great vertical ranges of strata, and the relation between the world-wide distribution of forms and this persistence, were noticed by D'Archiac, De Verneuil, Forbes and others. The identity of some species in the remote natural-history provinces of the existing state of things was established in spite of the dogmatic opposition of authorities; and then geologists accepted the theories that there were several natural-history provinces during every artificial period, that some species lived longer and wandered more than others, and that some have lasted even from the palæozoic age to the present.

Persistence of type was the title of a lecture delivered by Professor Huxley* many years ago; and this persistence has been admitted by every palæontologist who has had the opportunity of examining large series of fossils from every formation from all parts of the world.

Geological ages are characterized by a number of organisms which are not found in others, and by the grouping of numerous species which are allied to those of preceding and succeeding times, but which are not identical. Certain portions of the world's surface were tenanted by particular groups of forms during every geological age; and there was a similarity of arrangement in this grouping under the same external physical conditions. To use Huxley's term, the "homotaxis" of certain natural-history provinces during the successive geological ages has been very exact. The species differed; but there was a philosophy in the consecutive arrangement of high-land and low-land faunas and floras, and those of shallow seas, deep seas, oceans and reef-areas. The oceanic† conditions, for instance, can be traced by organic remains from the Laurentian to the present time, and the deep-sea corals now under consideration are representative of those of older deep seas.

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* Royal Institution. See also President's Address, Geol. Soc., 1870.

† P. M. Duncan, Quar. Jour. Geol. Soc., No. 101.

It is not a matter for surprise, then, that there being such a thing as persistence of type and of species, some very old forms should have lived on through the ages, whilst their surroundings were changed over and over again. But this persistence does not indicate that there have not been sufficient physical and biological changes during its lasting to alter the face of all things enough to give geologists the right of asserting the succession of several periods. The occurrence of early Cainozoic Madreporaria in the deep sea to the northwest of Great Britain only proves that certain forms of life have persisted during the vast changes in the physical geography of the world which were initiated by the upheaval of the Alps, the Himalayas, and large masses of the Andes. To say that we are, therefore, still in the Cainozoic or Cretaceous age would hardly be consistent with the necessary terminology of geological science.

During the end of the Miocene age and the whole of the Pliocene, the Sicilian area was occupied by a deep sea. The distinction between the faunas of those times and the present becomes less, year after year, as science progresses; and it is evident that a great number of existing species of nearly every class flourished before the occurrence of the great changes in physical geology which have become the artificial breaks of tertiary geologists. That the Cainozoic deep-sea corals should resemble, and in some instances should be identical in species with, the forms now inhabiting vast depths, is therefore quite in accordance with the philosophy of modern geology. Before the deposition of the Cainozoic strata, and whilst the deep-sea deposits of the Eocene age were collecting in the Franco-British area, there was a Madreporarian fauna there, which was singularly like unto that which followed it, both as regards the shape of the forms and their genera. Still earlier, during the slow subsidence of the great Upper Cretaceous deep-sea area there was a coral fauna in the north and west of Europe, of which the existing is very representative. The simple forms predominate in both faunas. Caryophyllia is a dominant genus in either; and a branching Synhelia of the old fauna is replaced in the present state of things by a branching Lophohelia. The similarity of deep-sea coral faunas might be carried still further back in the world's history; but it must be enough for my purpose to assert the representative character and the homotaxis of the Upper Cretaceous, the Tertiary, and the existing deep-sea

coral faunas. This character is enhanced by the persistence of types; but still the representative faunas are separable by vast intervals of time.—*Proceedings of the Royal Society.*

ON THE FOOD AND HABITS OF SOME OF OUR MARINE FISHES.

BY PROFESSOR A. E. VERRILL.

WHEN we consider the great importance and extent of our fisheries, it seems very remarkable that so little reliable information has been recorded concerning the habits, even of our most common and important species of fishes. It is certainly true that the habits of fishes, and especially of marine fishes, are more difficult to observe than those of birds and beasts, but this ought not to be a sufficient excuse at the present day, for the marked neglect of this department of Natural History. The nature of the food of the more abundant species, even including those that are most commonly sold as food, is still very imperfectly known. Observations must be made in great numbers in various localities and at all seasons of the year before we can obtain adequate knowledge of this subject.

During several years past I have improved such opportunities as have occurred to make observations of this kind, and although they are very incomplete, and often isolated, I am induced to present some of the facts thus ascertained; hoping that the attention of others may be directed to the same subject.

While spending a few days at Great Egg Harbor, on the coast of New Jersey, in April of this year, I dissected the stomachs of many specimens of the common fishes, which were at that time being taken in seines in the shallow waters of the bay, near Beesley's Point. The following were the principal results, in regard to their food. The Striped-bass or "Rock" (*Roccus lineatus* Gill) had its stomach filled with large quantities of shrimp (*Crangon vulgaris*) unmixed with any other food. This shrimp is very abundant on all sandy bottoms in shallow water along the whole coast, from Labrador to Cape Hatteras, and seems to contribute very largely to the food of many of our most valuable fishes.